

WHAT IS CLAIMED IS:

1 1. A method for processing a multi-carrier signal transmitted across
2 a channel, comprising
3 receiving the multi-carrier signal in time domain;
4 estimating a channel transfer function using a subset of the multi-carrier
5 signal in time domain;
6 transforming the multi-carrier signal from time-domain into frequency
7 domain; and
8 compensating for the channel transfer function using the estimated
9 channel transfer function.

10 2. The method of claim 1 wherein the subset of the multi-carrier
11 signal in time domain comprises training symbols.

12 3. The method of claim 2 wherein the estimating step comprises
13 performing a convolution of the training sequence.

14 4. The method of claim 3 wherein the estimating step further
15 comprises processing a weighing matrix in time domain.

16 5. The method of claim 4 wherein the processing of the weighing
17 matrix comprises performing a multiplication of the weighing matrix with the
18 convolved training sequence.

19 6. The method of claim 5 wherein the weighing matrix comprises
20 values that account for the finite time response of the channel and the position of zero
21 sub-carriers in the frequency domain.

1 7. The method of claim 2 wherein the convolution is performed as a
2 non-cyclical convolution.

1 8. The method of claim 5 wherein the estimating step further
2 includes determining an optimum time window within which the multiplication of the
3 weighing matrix occurs.

1 9. The method of claim 1 wherein the multi-carrier signal is
2 developed using orthogonal frequency division multiplexing.

1 10. The method of claim 9 wherein the channel comprises a wireless
2 multi-path channel.

1 11. A channel estimation method comprising:
2 receiving a time-domain multi-carrier signal representing a channel
3 training sequence;
4 performing a cyclic convolution function on the training sequence;
5 extracting a time window within which the received signal has optimum
6 amount of energy; and
7 multiplying a weighing matrix with the convolved training sequence to
8 arrive at channel estimates, wherein, the multiplying occurs during the time window
9 extracted by the extracting step.

1 12. The channel estimation method of claim 11 wherein the weighing
2 matrix comprises values that represent an amount of non-zero time samples of an
3 impulse response of the channel.

1 13. A method for communicating data between a transmitter and a
2 receiver separated by a channel, the method comprising:

3 at the transmitter end:
4 generating a plurality of modulated sub-carrier signals based on the data;
5 transforming the plurality of modulated sub-carrier signals into a
6 plurality of time-domain signals;
7 transmitting the plurality of time-domain signals across the channel; and
8 at the receiver end:
9 receiving the multi-carrier signal in time domain;
10 estimating a channel transfer function using a subset of the multi-
11 carrier signal in time domain;
12 transforming the multi-carrier signal from time-domain into
13 frequency domain; and
14 compensating for the channel transfer function using the
15 estimated channel transfer function.

1 14. The method of claim 13 the estimating comprises performing a
2 cyclic convolution on a training sequence embedded in the subset of the multi-carrier
3 signal in time domain.

1 15. The method of claim 14 wherein the estimating further comprises
2 multiplying a weighing matrix with the convolved training sequence.

1 16. The method of claim 15 wherein the step of multiplying occurs at
2 a window of time during which the multi-carrier signal has optimum energy.

1 17. In a multi-carrier data communication system, a receiver
2 comprising:
3 a channel estimator that receives a multi-carrier time-domain signal at
4 an input and generates a plurality of channel estimates at an output;

5 a time-domain to frequency-domain transform unit coupled to the output
6 of the channel estimator and configured to convert the multi-carrier time-domain
7 signal and the channel estimates from time domain into frequency domain; and
8 an equalizer coupled to an output of the transform unit and configured to
9 compensate the multi-carrier signal for channel effects using the channel estimates.

1 18. The receiver of claim 17 wherein the channel estimator
2 comprises:

3 a correlator coupled to receive a training sequence embedded in the
4 multi-carrier time-domain signal, and configured to perform a convolution operation
5 on the training sequence; and

6 a multiplier coupled to the correlator and configured to multiply a
channel estimation weighing matrix with an output of the correlator.

7 19. The receiver of claim 18 wherein the channel estimation
weighing matrix comprises values that account for the finite time response of the
channel and the position of zero sub-carriers in the frequency domain.

8 20. The receiver of claim 19 wherein the estimator further comprises
9 a timing circuit coupled to the correlator and the multiplier, and configured to extract
an optimum time for the multiplication performed by the multiplier.

1 21. The receiver of claim 20 wherein the correlator comprises a
2 matched filter that performs a cyclic convolution.

3 22. The receiver of claim 21 wherein the matched filter is also
4 configured to acquire timing of received signal for synchronization purposes.

1 23. The receiver of claim 20 wherein the estimator further comprises
2 a memory unit coupled to the correlator and configured to store the output of the
3 correlator.

1 24. The receiver of claim 23 wherein the estimator further comprises:
2 a delay unit having an input coupled to the input of the channel
3 estimator and an output; and
4 a multiplexer having a first input coupled to the output of the delay unit,
5 a second input coupled to an output of the multiplier, a control input and an output,
6 wherein, the multiplexer is configured to combine a payload portion of
7 the multi-carrier time-domain signal with the plurality of channel estimates.

1 25. The receiver of claim 25 wherein the time-domain to frequency-
2 domain transform unit is configured to perform a fast Fourier transform function.

1 26. A multi-carrier data communication system comprising:
2 a transmitter including:
3 a demodulator/deserializer configured to convert an input data stream
4 into a parallel plurality of multi-carrier signals;
5 a frequency-domain to time-domain converter having an input coupled
6 to the modulator/deserializer and configured to transform the parallel plurality of
7 multi-carrier signals from frequency domain into time domain at an output;
8 a guard period insertion block coupled to the frequency-domain to time-
9 domain converter and configured to insert a guard period in the output of the
10 frequency-domain to time-domain converter;
11 a serializer coupled to an output of the guard period insertion block and
12 configured to perform a parallel to serial conversion on the signal; and
13 a digital-to-analog converter coupled to the serializer and configured to
14 convert the digital signal into an analog signal and to transmit the analog multi-carrier
15 time-domain signal across a channel;

16 a receiver including:
17 an analog-to-digital converter coupled to receive the analog
18 signal and configured to convert the analog signal into a digital signal;
19 a deserializer coupled to the analog-to-digital converter and
20 configured to convert the digital signal into a plurality of parallel signals;
21 a channel estimator coupled to the deserializer and configured to
22 derive channel estimates using a training sequence embedded into to received time-
23 domain signal;
24 a guard period removal block coupled to an output of the channel
25 estimator and configured to remove the guard period;
26 a time-domain to frequency-domain converter coupled to an
27 output of the guard period removal block;
28 an equalizer coupled to the time-domain to frequency-domain
29 converter and configured to equalize the signal using the channel estimates;
30 a serializer/demodulator coupled to an output of the equalizer and
31 configured to generate an output data stream.

27. The data communication system of claim 26 wherein the channel estimator comprises:

3 a correlator coupled to receive a training sequence embedded in the
4 multi-carrier time-domain signal, and configured to perform a convolution operation
5 on the training sequence; and
6 a multiplier coupled to the correlator and configured to multiply a
7 channel estimation weighing matrix with an output of the correlator.

1 28. The receiver of claim 27 wherein the channel estimator further
2 comprises a timing circuit coupled to the correlator and the multiplier, and configured
3 to extract an optimum time for the multiplication performed by the multiplier.

1 29. The receiver of claim 28 wherein the correlator comprises a
2 matched filter that performs a cyclic convolution.

1 30. The receiver of claim 29 wherein the matched filter is also
2 configured to acquire timing of received signal for synchronization purposes.

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